The Anxiety Levels and Perceptions of Mathematics Learners from a Midwestern Technical College on Selected Classroom Climate Factors in Mitigating the Effects of Math Anxiety

by

Cheryl M. Sutter

A Research Paper
Submitted in Partial Fulfillment of the
Requirements for the
Master of Science Degree
in

Career and Technical Education

Concentration: Teaching

Approved: 2 Semester Credits

Dr. Amy Gillett

Dr. Amy Gillett

The Graduate School

University of Wisconsin-Stout

May, 2006

The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: Sutter, Cheryl M.

Title: *The Perceptions of Mathematics Learners from a Midwestern Technical College on Selected Classroom Climate Factors in Mitigating the Effects of Math Anxiety*

Graduate Degree/ Major: MS Career and Technical Education

Research Advisor: Amy Gillett, Ph.D.

Month/Year: May, 2006

Number of Pages: 54

Style Manual Used: American Psychological Association, 5th edition

Abstract

Adult learners (n=47) from a technical college were surveyed for their mathematics anxiety level, their perceptions on 10 relational coping strategies, and 17 affective learning environment qualities, related to potential reduction in math anxiety. The strategies and qualities were of an interpersonal and intrapersonal nature. Strategies asked for use and helpfulness; qualities requested interest and helpfulness to decreasing tension or worry. Brain function and resiliency validate promoting emotional health in math education. Results across low, medium, and high anxiety learners showed use of peer-related strategies as most used and most helpful while instructor and counselor strategies were much lower. Medium anxiety learners used strategies the most, believed to result from the combination of high need and sufficient academic self-efficacy to pursue strategies.

Qualities most helpful were an instructor who responds to class needs, friendships in class, appropriate humor, class discussion, and working with peers. Competition and electronic discussion were wanted by less than 7% of the participants.

Acknowledgments

My thesis admittedly took on a topic that has been written about many times. To venture into having anything newer to contribute or concrete to offer made my start to this process full of reservation. But having a gut feeling that there must be something worth thinking about on math anxiety that offers someone a hint or some language to meaningfully connect with learners who struggle with math anxiety, gnawed at me. It is with deep gratitude that the fuzzy beginnings and reformulation periods were supported by my thesis advisor, Dr. Amy Gillett. I have been buoyed by her sincere interest and encouragement in the short exchanges (and the not so short) we have had throughout this process. To feel commensurate support for a challenge is a gift and an educational ideal. Many thanks to Dr. Gillett for modeling this so well.

I would also like to anonymously thank the midwestern technical college and the math instructor who coordinated my access to their adult learners as participants for this study. Finding out what these learners thought was an audience I wanted to tap. The access and their participation have been appreciated.

Table of Contents

Page

Abstract ii

List of Tables vii

Chapter I: Introduction 1

Background 1

Statement of the Problem 2

Purpose of the Study 3

Research Questions 4

Significance of the Study 4

Assumptions 5

Scope and Delimitations 5

Definition of Terms 6

Chapter II: Literature Review 7

Introduction 7

Anxiety Described 7

What is the Brain Doing During Anxiety? 9

Learner Reactions to Math Anxiety 11

Coping Strategies and Classroom Climate Qualities 12

Resiliency 16

Chapter III: Methodology 20

Introduction 20

Selection and Description of Subjects 20

Instrumentation 20

Data Collection 22

Data Processing and Analysis 23

Limitations 24

Chapter IV: Results 26

Introduction 26

Demographics 26

Anxiety Composite Score 29

Coping Strategies 30

Learning Environment/Relational Qualities 36

Chapter V: Discussion, Conclusions, and Recommendations 39

Introduction 39

Discussion 39

Conclusions 41

Recommendations 43

References 46

Appendix A: Developmental Assets Related to Academia 50

Appendix B: Survey 51

List of Tables

Table 1: Coping Strategy Usage Comparison – Peskoff Study.....13

Table 2: Math Background Variables by Anxiety Level.....28

Table 3: Strategy Usage and Helpfulness – Low Anxiety.....31

Table 4: Strategy Usage and Helpfulness – Medium Anxiety.....32

Table 5: Strategy Usage and Helpfulness – High Anxiety.....33

Table 6: Coping Strategy Usage Comparison – Current Study.....34

Table 7: Coping Strategy Helpfulness Rankings.....35

Table 8: Interest in Classroom Qualities 37

Table 9: Top Ranked Qualities to Reduce Tension.....38

Chapter I: Introduction

"I just don't get it. Math isn't my thing and I'll never understand it." Learners facing a mathematics course who believe similar sentiments tend to feel defeated before they even begin the course. A sense of shutting down often occurs (Holley & Steiner, 2005; Godbey, 1997). Anecdotal evidence of this phenomenon is commonplace and mathematics anxiety has been documented across the country's spectrum of learner age ranges and their educational settings (Perry, 2004; Taylor & Fraser, 2003; Safford-Ramus, 2001).

Having a fear or dread of mathematics, whether found in academia or infiltrated with daily living, leaves some people cognitively and emotionally "stuck." Distancing themselves from mathematics may be a preferred reaction, but doing so exacerbates their lack of mathematical confidence and competency (Ryan, Gheen, & Midgley, 1998). By fearing math or assuming dismal results for the effort, individuals steer their career and leisure choices so they can minimize their math anxiety (Bankhead, 2002; Tobias, 1991).

Background

The early 1980's marked a new link between brain research and educational implications. Brain research has increasingly been considered through an educational lens in an effort to disclose conditions under which attention, memory, and conceptual understanding are impacted by the learning environment. Brain research allows understanding how the brain develops and changes over time, when critical periods are optimal for particular development (e.g. language, vision), and how the brain compensates for loss or damage (Sousa, 2006: Sprenger, 1999). Brain research findings have helped inform best practices within education in many ways and it offers insight as

to why math anxiety tends to be a chronic condition unless countered in meaningful ways. This will be discussed further in the literature review.

Anxiety, in general, has been challenging to define in terms of which aspects to include in its construct. The Merriam-Webster Collegiate Dictionary (2000) included the doubt a person has about a situation and one's capability to adequately respond to it. The New Oxford American Dictionary (2001) recognized the aspect of an uncertain outcome. Mathematics anxiety is considered a state-specific form of general anxiety. Further description of general and math anxieties, along with symptoms of math anxiety are included the literature review.

A healthy learning climate is commonly understood as integral to the success of all learners, but may be particularly significant for math anxiety learners. This study sought literature about classroom climate components in relation to math anxiety. It focused on those that signal the importance of interpersonal and intrapersonal relationships.

Statement of the Problem

Safford-Ramus (2001) reported that between 1980 and 2000, only 10% of abstracts for published, mathematically-oriented dissertations (n=12) were related to interventions for adults with math anxiety. Furthermore, the dissertations neglected certain aspects of mathematics education, including communication through writing and cooperative activities (Safford-Ramus, 2001). These topics relate to the affective and relational natures of math education which have been the angle of math anxiety considered in this study.

Math anxiety has several inherent challenges related to its study. One challenge is working with definitions that emphasize different aspects of the phenomenon, of which different learners experience various aspects and with different intensities. Another challenge regards the ongoing assimilation of current brain research findings and how they develop or hone subsequent attempts to decrease math anxiety. And considering math anxiety is an "old" topic, it may be challenging in some circles to keep collegial conversation fresh and energy directed on potentially helpful strategies. There is great demand on academic departments to meet a broadening array of institutional and community needs. In recognition of expanding and competing demands of education, it is hoped that developing an understanding of current brain research, honing the learning environment toward affective health, and acquiring frequent learner input can efficiently contribute toward minimizing math anxiety.

In this study, perceptions by a sample of post-secondary math learners were collected to offer their perspectives on the prevalence and or effectiveness of selected coping strategies and classroom climate qualities related to learning math. The learners were surveyed to ascertain their math anxiety levels for potential relationship to their perception data.

Purpose Statement

The purpose of this study was to document and compare math anxiety levels with perceptions of math learners from a midwestern technical college on interpersonal and intrapersonal coping strategies and affective classroom climate factors potentially available within math learning environments. Data was collected in April 2006 using a three part survey.

Research Questions

The following questions helped guide the search for relevant literature and target the nature of the researcher's interests.

1. Are there any approaches to understanding or conceptualizing math anxiety that might freshen conversation on this topic?

2. As customers of math education, what do learners of a midwestern technical college perceive as helpful coping strategies for their math learning environment that involve personal relationships?

3. Beyond coping strategies, what support or relational learning qualities do these learners associate with tension reduction in math?

Significance of the Study

With math anxiety's presence over decades and across learner age groups, the psychological and educational professions continue to deal with a phenomenon that hinders the pursuit and enjoyment by learners of activities in their personal, academic, and professional lives intertwining with mathematical content.

Math anxiety reduction appears related to a healthy learning climate. One synonym used for a healthy learning climate is safe space. Little information has been written to account for a learner's perspective of safe space (Holley & Steiner, 2005). Determining factors that learners view as creating or enhancing a healthy learning climate, with an emphasis on factors that reduce excess tension and worry, is a goal with professional practice implications.

Assumptions

Research reported for this study attempted to focus specifically on post-secondary math learners. When content was not found to address this population, some research using other populations (e.g. younger math learners or post-secondary non-math learners) was reported. While there was no assumption that findings for these populations transfer in a one-to-one fashion to post-secondary math learners, it was assumed that the research had something valuable to add to the discourse.

It was also assumed that all survey participants have provided honest and candid feedback to all survey items.

Scope and Delimitations

The scope of this study involved one midwestern technical college which has multiple campuses within a state system. The sample of learners who participated in the survey was currently attending the same campus during April 2006. At the time, participants were enrolled in one of the following face-to-face math courses: Trigonometry, Business Math, or Introduction to College Mathematics. These courses were taken as requirements within their respective programs. The desired sample size for each course was 50 or more, however 30 or more would allow applying correlation statistics within and between courses. Fewer than 30 participants per course would limit the statistics to frequencies and measures of central tendency. The degree of generalizability to this campus for these courses is dependent on how representative the sample is of the population attending this campus. Generalizability beyond this campus can only be speculative, given sample sizes and the amount of demographic information collected to compare with other populations.

Definition of Terms

Below are several terms defined according to their use in this study. The term anxiety, shown below, and the term math anxiety, not shown below, will both have further description in the literature review.

Anxiety –

> an abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with it. (Merriam-Webster Collegiate Dictionary, 2000, p. 53)

Classroom climate or learning climate – the affective nature of the space and relationships comprising a learning environment; this includes, but is not limited to, the aesthetics, comfort, and appropriateness of the learning space and the levels of mutual respect, personal sharing, resource access, inclusion of alternate viewpoints, support and encouragement, risk and reward, and the placement of decision making in the environment.

Safe space –

> a classroom climate that allows students to feel secure enough to take risks, honestly express their views, and share and explore their knowledge, attitudes, and behaviors. Safety in this sense does not refer to physical safety. Instead, classroom safe space refers to protection from psychological or emotional harm. (Holley & Steiner, 2005, p. 50)

Self-efficacy – the thoughts and beliefs about one's power or capacity to produce a desired effect; the thoughts and beliefs about one's personal ability to achieve results.

Chapter II: Literature Review

Introduction

This chapter will present interrelated ideas for understanding math anxiety and selected approaches to helping reduce it. These include brief descriptions of general anxiety and math anxiety, a section on brain function, a section on learner reactions under anxiety perceived conditions, and a look at classroom qualities and coping strategies considered helpful to minimizing anxiety. The classroom qualities and coping strategies of focus in this study relate to affective and relational characteristics shared among learners and the instructor when participating in face-to-face classroom settings. An emphasis on resiliency is considered.

Anxiety Described

Baloglu (1999) has researched definitions of general anxiety, mathematics anxiety, and statistics anxiety in a comprehensive attempt to consolidate years of descriptors for these phenomena. Statistics anxiety will not be considered in the current study. He found variations and occasional discrepancies between the 1950's to the time of his writing, however three general anxiety constructs surfaced.

General anxiety is composed of trait anxiety and state anxiety, two components which are widely accepted as descriptive of anxiety (Baloglu, 1999). Trait anxiety is the individual's natural propensity toward anxiety and is considered a relatively stable, personal characteristic, while state anxiety refers to a specific situation perceived as threatening that varies in duration. General anxiety may also be viewed as comprising cognitive and affective components (Olson, cited in Baloglu, 1999). This construct attempts to distinguish between worry-type elements of anxiety and its emotional

elements. A third construct considers general anxiety as having cognitive, behavioral, and emotional elements (Wine, cited in Baloglu, 1999). The constructs are not exclusive of one another.

Math anxiety is "an inability by an otherwise intelligent person to cope with quantification, and more generally, mathematics" (Kranz, cited in Perry, 2004, p. 321). Similarly it has been described as "the feelings of tension and anxiety that interfere with the manipulation of numbers and solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, cited in Baloglu, 1999, p. 4). Less definitional sounding, Kitchens (1995, p. 6) indicated "any feeling that prevents you from learning math in a natural way as you did as a young child...is math anxiety." Kitchens placed emphasis on the learner's thoughts and fears while downplaying any lack of capacity to learn math. And while a comprehensive review of math anxiety definitions over time indicate there has not been full agreement on what it is (Kazelskis, cited in Baloglu, 1999), it is not to include or to be confused with the construct of test anxiety (Arem, 2003), a separate phenomenon about test taking skills or fears of being evaluated.

Symptoms of math anxiety experienced by different learners are many. They can include nausea, perspiration, hot tingling sensations, extreme nervousness, inability to hear the instructor, upset or distraction from noises like crumpling paper, inability to concentrate, negative self-talk, headache, stomachache, muscle tension, a blank mind, sweaty palms, shortness of breath, and others (Arem, 2003; Kitchens, 1995).

Anxiety's symptoms arise from the perceptions and messages a learner processes (Arem, 2003; Kitchens, 1995). Messages may be personal in the form of thoughts and self-talk (a continuous inner dialogue) or external in the form of verbal comments and

body language from those around the learner. The messages from people significant to the learner can be particularly impactful, either positively or negatively, and both researchers advocated careful selection of the company a math anxious learner keeps.

What Is The Brain Doing During Anxiety?

Prior to the 1980's, learning about the human brain required autopsying cadavers, a limited discovery mode given the organ was no longer functioning. Recent decades have seen tremendous growth in neuroscience due to brain-imaging and testing techniques (Sousa, 2006; Sprenger, 1999), allowing real time acquisition of brain data in response to varying stimuli.

Some brain anatomy background allows understanding how certain approaches to minimizing math anxiety have validity grounded in neuroscience. To that end, a brief orientation to the brain follows.

Scientists have divided the exterior regions of the brain into four lobe areas with different, and some overlapping, functions (Sousa, 2006). The frontal lobes are behind the forehead and continue to mature into early adulthood. This region is responsible for planning, judgment, higher-order thinking, problem solving, regulating excesses of the emotion system, and personality. This is where most of working memory happens, so it is an area where focus occurs. The temporal lobes are above the ears and responsible for sound, music, speech (primarily on the left), face and object recognition, and some long term memory. The occipital lobes reside at the middle back of the brain and handle visual processing. The parietal lobes are at the top back of the brain and deal with spatial orientation, calculation, and certain types of recognition.

The brainstem is evolutionarily the oldest and physically the deepest brain area (Sousa, 2006; Sprenger, 1999). It is the home base for 11 of 12 body nerves and it monitors and controls heartbeat, respiration, temperature, and digestion. It also is home to a screening system that determines which incoming sensory data is more important than others. Data perceived as survival-related gets a highly important status, while other data drops out within a few seconds. The brainstem is a survival-oriented structure, and the physical symptoms experienced by learners with math anxiety indicate their brains have perceived stress or threat.

The limbic system, minimally a convenient term for a group of four structures with different functions, resides just above the brainstem in the center of the brain and generally has functional duplication in both brain hemispheres (Sousa, 2006; Jensen, 1998). The system interacts with many parts of the brain and is responsible for emotions, sleep, and the production of most of the brain's chemicals. One structure, the thalamus, receives sensory data first and then monitors it for survival content, using past experiences to determine importance (Sousa, 2006). Input of a higher priority inhibits brain processing of lower priority data. Any threat is processed immediately, causing adrenaline and other chemicals to be released brain-wide, shutting down unnecessary brain activity. In this case, "unnecessary brain activity" refers to learning or other activity not related to survival. The use of past experiences in determining importance is partly due to the amygdala, a limbic system structure thought to encode an emotional message, assuming there is one, whenever a memory is marked for long-term memory. As a result, as a long-term memory is recalled, say from sixth grade math class, cognitive elements (e.g. definition, formula) and emotional elements (e.g. panic, failure) are part of recall.

Recalling the emotion is enough to re-experience the emotions and physical manifestations from the memory.

When a learner experiences a threat, real or perceived, the brain reacts to the situation the same way (Sprenger, 1999; Beck, cited in Baloglu, 1999). Anxiety hijacks normal cognitive processing. Anything that embarrasses a learner becomes a threat that inhibits the brain processes used in learning (Jensen, cited by Tileston, 2000). "When threat exists, the brain operates in survival mode and while we can learn in that mode, we do so at the expense of higher-order thinking" (p. 47).

Learner Reactions to Math Anxiety

Among learning strategies, help-seeking is a valuable skill. As young learners mature, they begin to sense their own academic prowess and develop recognition for when they need assistance (Ryan, Gheen, & Midgley, 1998). Help-seeking combines a learning strategy with a social interaction, and both are important types of support (Ryan, Patrick, & Shim, 2005). Math anxious people, however, feel they are alone (Salinas, 2004; Kitchens, 1995). They fear being judged as not having ability when they ask for help (Arem, 2003; Ryan, Gheen, & Midgley, 1998, Tobias, 1993). Thinking it would be far better to appear disinterested, not attend class, or not turn in homework than to be identified as producing work reflecting low performance, some learners will opt to avoid the very behaviors that could assist their learning. According to Spandel (2005), asking learners about what grades mean to them indicates, "many students will tell you that the worst grade to receive is a C because while an F means that you didn't try or didn't care...a C indicates that you did your best but still failed – and that's depressing." Fear of

exposure and embarrassment prevents constructive action (Kitchens, 1995; Tobias, 1993).

Self-efficacy is the notion, one's thoughts and beliefs, about having the personal power or capacity to produce a desired effect. Academic self-efficacy refers to a learner's judgment about his/her capability to successfully complete schoolwork (Pintrich & Schunk, cited in Ryan, Gheen, & Midgley, 1998). Separate from the possibility of lacking prerequisite knowledge, most college undergraduates have the cognitive capacity to handle advanced algebra, intermediate statistics, and college calculus but they do not believe they can (Tobias, 1991). Learners with high levels of academic self-efficacy are more likely to perceive help seeking as a constructive learning strategy (Ryan, Patrick, & Shim, 2005); while learners with low academic self-efficacy are more likely to think their help-seeking behaviors are interpreted by others as low ability. These learners are less likely to seek help. Seeking help is positively related to the affective environment of the learners' classroom (Stipeck et al., cited in Patrick et al., 2003).

Coping Strategies and Classroom Climate Qualities

A math anxiety study at a community college with 279 learners and 50 faculty members from math and counseling departments was conducted (Peskoff, 2001). The study was aimed at determining three things: learners' levels of anxiety with their perceptions and use of ten coping strategies, math and counseling faculty perceptions of helpfulness of those coping strategies, and a comparison of strategy helpfulness among the three groups of participants. Three outcomes resulted.

First, low anxiety learners (as determined by the Composite Math Anxiety Scale) employed a wider variety of strategies than the high anxiety learners. This was

understood as low anxiety learners were in a better position to pursue coping strategies, considering that anxiety in general has a disabling effect on learners (Peskoff, 2001).

A second outcome (see Table 1) was that high anxiety learners used only 2 of the 10 coping strategies more than low anxiety learners (tutoring and counselor discussion) and these 2 were considered by all learners as least helpful among the 10 (Peskoff, 2001).

Finally, there was general agreement among the groups regarding perceived helpfulness of these strategies (Peskoff, 2001). All groups ranked the best two strategies as completing one's homework on time and letting the instructor know when course content was not being understood. They also ranked extra time to study for an exam and asking questions in class as among the best strategies of the 10 studied. Staff, however, considered tutoring a more helpful strategy than did learners.

Table 1 Coping Strategy Usage Comparison – Peskoff Study

Coping Strategy	Utilized More By Learners With	
	Low Anxiety	High Anxiety
Complete Homework On Time	X	
Communicate with Instructor if You Do Not Understand	X	
Allow Extra Review Time Before Exams	X	
Ask Questions In Class	X	
Use Additional Texts or Review Books	X	
Discuss Class Experiences or Difficulties with Other Learners	X	
Remind Yourself You Are A Good Student	X	
Include Relaxation (exercise, physical activity, or systematic relaxation)	X	
Use Tutoring Services		X
Discuss Difficulties with Counselor		X

Math anxiety researchers, when considering the affective realm of learning math, believe adult learners need opportunities to express their thoughts and feelings about math and to become aware that other competent adults also have math uncertainties (Godbey, 1997; Archambeault, 1993; Tobias, 1991). Emotion either impedes or motivates learning (Dirkx, 2001). Negative self-talk and negative feelings will prevent a learner from concentrating on math (Tobias, 1991), while letting out frustration is important to being able to focus attention on problem solving (Salinas, 2004).

Tobias (1991) held math clinics or math anxiety reduction programs where university learners countered myths about learning math and discussed thoughts and feelings about math. This process occurred en route to cultivating behaviors practiced by strong math learners (i.e. hard work, persistence, alternate problem solving approaches). According to Tobias (1993, 1991), influential to the clinics were: using personally written math autobiographies to discover past rub spots or negative math experiences; meeting with other math anxious learners to share feelings and thoughts (i.e. group de-tox sessions), and gaining awareness of one's negative self-talk for learning to replace it with more constructive messages. Clinic meeting time was separate from any class. It allowed group bonding and created an atmosphere of growing trust that developed toward incorporation of math content in small doses. The math instruction continually allowed expression and processing of how learners perceived new math experiences. Tobias claimed that over 600 university learners went through the clinic in the 1970's and 1980's and all went on to take and pass calculus (1991).

Written exercises within the math anxiety clinics helped learners grasp the dialogue they continually heard inside themselves and to better express and challenge

those thoughts. This relates to one of the findings of a study among 24 pre-service elementary teachers taking an undergraduate math course (Salinas, 2004). The use of reflective notebooks, with entries requested daily after class, contained diary-like entries, journal writing, and personal understandings. These notebooks were reviewed by the instructor every one or two weeks, informing the instructor of questions and individual insights in which to make class adjustments, and offering learners written comments and encouragement made in response to their loggings. The study collected data via the learner notebooks, an instructor notebook of content related to class happenings, learner surveys at semester's end, and interviews of a random sample of learners. As a result, the study revealed three themes.

Learner writings indicated they acquired new understandings of math, gained awareness of their understanding relative to the learning community (they generally worked in groups), and prompted their own self-evaluation (Salinas, 2004). New understandings represented things like math does not always have one right answer nor a single approach for problem solving, and math is not "'just know(ing) what steps to do, but how and why we use the steps'" (Salinas, 2004, p. 320). Learning one's place in the learning community came from sentiments of "'I'm not the only one'" (p. 322), "'I think I work better with people'" (p. 323), and "'Being able to turn in my work and questions and then receiving responses from the teacher helps me understand better'" (p. 323). Self-evaluation came across in reflecting on one's thoughts and feelings or putting them in some perspective. One learner wrote, "'Fractions have always scared me. I had a hard time motivating myself to even attempt this homework. But, somehow reflecting in my notebook gave me a way to let out what I felt'" (p. 324). Salinas indicated frustration and

attitudes were seen by learners as hampering their progress. The process of writing allowed the frustration, as recorded by one learner, "(to) 'get it out of my system so I can concentrate better'" (p. 325).

Resiliency

Promoting resiliency among learners may be an umbrella perspective to apply to math competency (Malloy & Malloy, 1998) and by association, math anxiety. Resiliency is the capacity to bounce back from adverse circumstances. Merriam-Webster defined it as "an ability to recover from or adjust easily to misfortune or change" (2000, p. 993). For learners with math anxiety, drawing upon their resiliency resources is part of mounting a coping response. Sources to follow bring resiliency into the math picture, pointing to its ties with interpersonal and intrapersonal health.

Learner characteristics, believed to contribute to passing a state mandated high school Algebra I course, were identified by a group of math teachers (n=20) studied in four North Carolina high schools that had general academic profiles at or above statewide averages (Malloy & Malloy, 1998). Data collection methods included teacher questionnaires, observations of teachers and students in algebra classes, pre- and post-observation teacher interviews, school-based focus groups with teachers, and student achievement data by school. The learner characteristics were corroborated by the researchers and included "taking responsibility for learning, persistence, self-confidence, risk taking, collaborative interactions, transfer of learning, enthusiasm, help seeking, and sense of humor" (p. 315). The researchers considered these characteristics as themed around resiliency. They proposed resiliency as worth infusion into math education for all learners.

Practices employed by the teachers, as observed by Malloy and Malloy (1998), supported resilient learner characteristics, even though the teachers primarily identified themselves and were observed as users of traditional teaching methods. The practices were constant monitoring of student learning (e.g. daily homework, expectations of students explaining solutions to classmates, never accepting self-defeating responses to challenging problems); encouraging alternate routes to problem solving (e.g. allowed students who developed nontraditional solutions to share them with the class, prompting others to explore other routes); encouraging risk taking (e.g. pairing marginal and higher-performing students together to make contributions collectively, learners seeing that correct or incorrect work can be learned from); creating enthusiasm for a stimulating class; and using collaboration and humor (e.g. encouraged conversation that kept learners on task, allowed working together to buoy spirits when work was difficult).

> From the focus group feedback with the teachers, the researchers reported, a rigid, no-nonsense approach in traditional mathematics does not hinder the progress of high-performing students because their self-confidence and persistence thrive in an austere and competitive atmosphere. But conversely, that same atmosphere tends to create apprehension on the part of the low and marginal students because it tends to stultify creativity and discourage risk-taking behavior and collaboration. (Malloy & Malloy, 1998, p. 316)

The teachers added that humor helped student willingness to try math problems and reduced tension.

Search Institute, a non-profit organization located in Minneapolis, MN, has as its primary goal to determine the factors or assets that help children and young people

develop into healthy, well-adjusted people, for themselves and for their communities. They have conducted and reviewed studies showing there is a positive correlation between levels of developmental assets youth have and various measurements of academic achievement (Scales & Roehlkepartain, 2003).

Developmental assets are defined as "positive factors in young people, families, communities, schools, and other settings that have been found to be important in promoting young people's healthy development" (Scales & Roehlkepartain, 2003, p. 2). Forty developmental assets, 20 considered external and 20 considered internal, have been articulated by Search Institute. Beyond studies that link higher asset levels to greater academic competency, analyses of surveys of over 215,000 youth across racial/ethnic and socio-economic groups have determined that asset development applies across these groups both in terms of the reduction of risk behaviors and the increase of thriving behaviors (Sesma & Roehlkepartain, 2003). Both the reduction of risk behaviors and the increase of thriving behaviors play roles in academic success.

Educational professionals and the learning environments they promote account for approximately one-fourth of the external assets and three-fourths of the internal assets. Post-secondary social work learners in a study by Holley and Steiner (2005) attributed more responsibility to the instructor for creating safe space than they did to their peers or themselves. Safe space was defined as "a classroom climate that allows students to feel secure enough to take risks, honestly express their views, and share and explore their knowledge, attitudes, and behaviors" (Holley & Steiner, 2005, p. 50). Safe space is not to be understood as a learning environment without any stress, conflict, or challenge, but from this researcher's perspective these elements are guided by respect and

coupled with commensurate support to match the challenge at hand. The assets associated with academia are noted in Appendix A with categories as determined by Search Institute. The assets have been identified and described in terms of youth ages 12 to 18.

So, where might assets have connection with reducing math anxiety? The common quality may be in how steeped the assets are in interpersonal and intrapersonal relationships within the learning environment. With more assets in a learner's personal arsenal, researchers have theorized that adverse circumstances, including academic difficulties, are more likely to be countered with resiliency characteristics and appropriate help-seeking behaviors (Scales & Roehlkepartain, 2003).

Chapter III: Methodology

Introduction

This chapter outlines subject selection and description, details the nature of the survey used to acquire data, and provides the data collection procedures, types of data analysis, and limitations of the methodology.

Selection and Description of Subjects

Adult learners who attend a technical college do so for a variety of reasons and at different times in their lives. They may be seeking a first career, skill enhancement, voluntary or involuntary career change, or personal interest. This study's participants were volunteers from three math courses held at a midwestern technical college. All learners in attendance at their face-to-face math class were asked to participate in the survey.

Though not mandatory for the study, course selection considered whether learners might represent some differences in quantity of prior math preparation at the post-secondary level. As a result, one course with a prerequisite math course and two courses without a math prerequisite were surveyed.

Instrumentation

A hardcopy, anonymous survey was used to gather data. Brief demographic information consisted of six items, mostly fill-in-the-blank. Requested data included the participant's current math course, program name, gender, age, number of years of high school math passed, indication of whether high school math was taken through block scheduling, number of math courses passed since high school graduation or GED attainment, and how many years it had been since taking a prior math course. These items

were included to allow potential identification of differences or correlations in survey responses by gender, age, and math background. The block scheduling question was only included to determine how many participants may have had to interpret how to respond to the question regarding the number of high school math years. One open-ended question concluded the demographic background to allow any clarification, if desired.

The remainder of the survey consisted of three sections: one on personal anxiety with math, the second on interpersonal and intrapersonal coping strategies experienced in math, and the final section on selected affective qualities wanted in a math learning environment, with specific interest on those that learners considered helpful to reducing math tension.

The math anxiety section was modeled after a ten question, Likert math anxiety subscale taken from the Fennema-Sherman Mathematics Attitudes Scales Test (1976). Some subscale ideas were adopted with minor changes for clarity, while others were modified or replaced to better represent more current literature. One open-ended question was added to conclude this section, allowing learners to clarify answers or add information, if desired.

The second section on 10 coping strategies was modeled after a study on math anxiety and coping strategies among adults from a community college (Peskoff, 2001). Using Likert-type questions, the model prompted how often a coping strategy was engaged in and then its effectiveness as perceived by the learner. For strategies not experienced, the learner could still indicate how effective he/she thought they would be if they were to be used. The current study employed this format. The six coping strategies that involved classroom or educational personnel from Peskoff's study were adopted with

minor modifications, and the remaining coping strategies were developed by the researcher. Questions were designed so that this section focused on math coping strategies with an interpersonal or intrapersonal nature.

The final section, created by the researcher, allowed bringing in additional affective and relational qualities that learners may want and find helpful to tension reduction. The format provided a list of 17 qualities that learners were asked to checkmark if they were considered as desirable in their math learning environment. The final question had learners indicate which of their chosen qualities were also considered as helpful to tension reduction.

Outside of this study, the survey has not had replicated use; therefore, its statistical measures of validity and reliability are unknown. The survey was piloted with a class of 16 graduate students from an area university for intended content validity, clarity, and approximate time length for completion. Minor revisions were made to wording based on their feedback. Several changes were made to the demographic background after the pilot to better capture each learner's self-reported math background.

The survey was presented in booklet form with the consent form on page one, followed by three survey pages. Participants were offered an identical copy of the consent form to keep for contact information. A copy of the finalized survey is located in Appendix A.

Data Collection

The Institutional Review Board of the researcher's university campus approved this study's proposal and survey. Permission to survey was then sought from a midwestern technical college and subsequently denied due to a sense of survey burnout

within the institution. Permission to survey was then sought and obtained from an alternate midwestern technical college prior to survey administration. The surveys were completed and collected at the start of each class. Variability in environment was limited to the time of day as the classes met in the same room, on the same day, and were taught by the same instructor. Survey time ranged from 7 to 15 minutes based on arrival time of the participant. The researcher administered the surveys and batched them by course enrollment.

Data Processing and Analysis

The Statistical Package for the Social Sciences (SPSS), Version 12, was utilized for processing and analyzing the data. The raw data was loaded into the program. After entry of raw data, a random audit of approximated 25% of the data, as well as data that looked curious, was conducted. One error was found and corrected.

Anxiety questions had Likert responses of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD). These responses were assigned values of one to five, respectively, for the positively worded anxiety statements (e.g. I usually don't worry about my ability to solve math problems). Reverse coding within SPSS was used on the negatively worded statements (e.g. I get a sinking feeling when I think of trying hard math problems). Composite anxiety scores could vary from 10 (lowest) to 50 (highest). The low anxiety range was defined as 10 – 24 (the lower 35% of the scale), the medium range was 25 – 35 (the middle 30%), and the high range was 36 – 50 (the upper 35%).

Frequencies, percents, and cross-tabulations were calculated using SPSS. Measures of central tendency were calculated manually. Based on sample sizes, no correlation data

were calculated, with the exception of one Spearman rho. The results can be found in Chapter IV.

Limitations

A variety of literature indicates there is an inverse relationship between math background and level of anxiety (Ulrich, 1989; Betz, 1978). As a result, the survey participants were asked to indicate the length of time since their prior math course, how many years of high school math they passed, and how many courses of math were passed since high school graduation or GED attainment. The intention was to have some means for gauging the recentness and quantity of math background. The survey did not request the specific coursework taken, or how successful learners were in those courses beyond specifying the courses were passed.

Continuing with math background, the survey did not request the quantity or depth that life experiences with math may have played for some participants. For example, a non-traditional learner who was changing careers may have had significant math experience in some content areas through handling the family finances or through work responsibilities. This type of data, while meaningful to one's background, did not seem logistically feasible to collect through a short survey. Data of this nature would be better collected through interviews or case studies. As a result, no attempt was made to collect and compare the value of those life experiences, so the depth and recentness of math background was confined to academic coursework.

As mentioned in the Subjects section of this chapter, adults attend technical colleges for a variety of reasons. The motivations or rationales for learners pursuing their particular programs which resulted in their math course requirements were not

considered. The degrees to which these elements play a role in defining participant anxiety and their perceptions of helpful factors were not within the scope of this study.

Chapter IV: Results

Introduction

This chapter consists of a brief overview of how participants were acquired, the demographics describing them, the anxiety levels and comments of participants, their use and perceptions of helpfulness on 10 coping strategies, and their interest and perceptions of helpfulness on 17 affective learning environment qualities. Research Questions #2, #3, and #4 will be addressed as the respective data are presented. Due to Research Question #1 being covered by the literature review, its discussion has been included in Chapter V.

A survey was offered to five sections of three math courses held by a midwestern technical college. A total of 61 learners were registered for these sections and 48 were in attendance on the day of surveying. The survey was administered to determine the learners' math anxiety levels and their perceptions of strategies and qualities that may have been part of their past learning experiences in math. Of the 48 learners, 47 chose to participate by taking the survey, a return rate of 97.9%. These learners made up 77.0% of the registered learners in these face-to-face classes.

Demographics

There were 26 male, 20 female, and 1 unrecorded participants in this study. They were pursuing a variety of programs, with over half seeking Criminal Justice, Mechanical Design, or Architectural Commercial Design. As program requirements, they were either enrolled in Trigonometry, Introduction to College Mathematics, or Business Math (38.3%, 31.9%, and 29.8%, respectively, n=47).

Thirty-four participants were traditional learners (ages 18-25 years, 73.9%) and 11 participants were non-traditional learners (ages 26+, 23.9%). One 17 year old learner,

unbeknownst to the researcher, also participated (2.2%). Any subsequent reference to traditional and non-traditional learners will group this participant with traditional learners.

Math background was collected through three variables. The amount of high school math passed ranged from 0 to 5 years. The data showed 20.5% had 0 to 2.5 years and 79.5% had 3 or more years (n=44). Seventeen participants (37.0%, n=44) indicated they had some high school math through block scheduling. Eight of these indicated they passed 4 years and the one learner who indicated 5 years did also. Seven of the remaining eight learners showed 2 or 3 years, and the remaining learner indicated 0 years passed.

The second background variable indicated the quantity of post-secondary math coursework passed, ranging from 0 to 4 courses. The distribution was 28.3% with no course, 30.4% with one course, 21.7% with two courses, 15.2% with three courses, and 4.3% with four courses (n=46).

The final background variable was the time elapsed since a prior math course and this ranged from 0 to 28 years. The majority of these learners (64.4%) had a one year break or less (n=45). Seven learners (15.6%) had a 2 to 4 year break, five learners (11.1%) had a 5 to 19 year break, and four learners (8.9%) had a break greater than 20 years. Table 2 collectively shows the three math background variable frequencies and their measures of central tendency, categorized by anxiety levels.

Table 2 Math Background Variables by Anxiety Level

High School Math Passed (yrs)	Anxiety Level Low	Medium	High
0	0	0	1
1	0	0	1
2	2	2	2
2.5	0	1	0
3	6	6	0
3.5	0	1	0
4	14	5	2
5	1	0	0
Mean	3.6	3.2	2.2
Median	4	3	2
Mode	4	3	2,4
	n=23	n=15	n=6
Post-Secondary Math Courses Passed (#)			
0	5	5	3
1	8	5	1
2	4	3	3
3	4	3	0
4	2	0	0
Mean	1.6	1.2	1.0
Median	1	1	1
Mode	1	0,1	0,1
	n=23	n=16	n=7
Time Since Previous Math Course (yrs)			
0 - 1	16	10	3
2 - 4	4	2	1
5 - 10	2	2	0
11 - 20	0	1	1
21 – 28	1	0	2
Mean	2.8	2.9	10.7
Median	1	1	2.5
Mode	1	0,1	1
	n=23	n=15	n=7

Anxiety Composite Score

Learner anxiety scores ranged from 10 – 50, matching the theoretical range. The low, medium, and high anxiety percentages for male participants were 61.5, 30.8, and 7.7, respectively. For female participants, the respective percentages were 35.0, 40.0, and 25.0. Since female participants in this sample had higher anxiety by category than their male counterparts, the non-parametric Spearman rho correlation was calculated between gender and the three variables of math background to see if any statistical significance existed between gender and background. Mild statistical significance was found at the 0.029 level for gender as related to time length since a prior math course (rho=0.325), and not with the other two variables.

Composite scores by course yielded low, medium, and high anxiety percentages for Trigonometry learners at 61.1, 33.3, and 5.6, Introduction to College Mathematics learners at 53.3, 33.3, and 13.3, and Business Math learners at 51.1, 34.0, and 14.9, respectively.

The open-ended question which concluded this survey section allowed clarification or comments by participants about their comfort level. Eight learners offered comments that concurred with their anxiety level. For example, two highly anxious learners (composite scores of 49 each) wrote, "I don't understand math, it is very hard for me", and "I strongly hate math!!" Two low anxiety learner wrote, "I like math" (composite score of 23), and "I enjoy math! It's the instructors that make people understand it which makes them (people) feel at ease or ill with math" (composite score of 14). Additional comments collected indicated some math is easier than others, a person can enjoy one type of math but not another, math homework can go well while tests do

not, and that Core Math in high school did not adequately prepare that learner for college level math.

Coping Strategies

The coping strategy data had a response range of 1 (not at all) to 5 (a lot). Of the middle options, only 3 was labeled (somewhat), leaving 2 and 4 as additional relative options. The data, organized by anxiety level, have been presented in Tables 3, 4, and 5. Usage and helpfulness per strategy have been combined on one table for each anxiety level. Usage results will be reviewed first for all anxiety levels and then helpfulness will be addressed in response to Research Question #2.

For low anxiety participants (n=23, Table 3), five of the strategies were used somewhat or more by 70 – 80% of the participants. These were working with a group in class, working with a partner in class, asking the instructor questions in class, discussing experiences or difficulties related to math with other students from class, and reminding oneself of being mentally capable when starting to feel incompetent. The sixth item used most was studying with a partner outside of class (50.0%).

Strategies used least were tutoring (83.3% never), speaking with a counselor about math experiences or difficulties (79.2% never), phoning or emailing the instructor to discuss material not understood (70.8% never), and meeting the instructor for help (62.5% never). These learners, however, had a favorable perception of tutoring, with 75.0% thinking it could be somewhat or more helpful.

The medium anxiety participants (n=16, Table 4), showed higher relative usage for its top five strategies (81.4 – 93.8% at somewhat or more). These were working in a group in class, discussing experiences or difficulties related to math with other students

from class, asking the instructor questions in class, having a partner in class, and having a partner outside of class. The sixth strategy was reminding oneself of being mentally capable (62.5%).

Table 3 Strategy Usage and Helpfulness - Low Anxiety Participants (n=24)

Usage (%)						Helpfulness (%)				
1-Not at all	2	3-Somewhat	4	5-A lot	Coping Strategy	1-Not at all	2	3-Somewhat	4	5-A lot
83.3	4.2	8.3	0	4.2	Tutor	20.8	4.2	37.5	20.8	16.7
79.2	8.3	12.5	0	0	Counselor	33.3	8.3	54.2	4.2	0
33.3	16.7	37.5	12.5	0	Partner Outside Class	12.5	0	47.1	33.3	12.5
8.3	16.7	45.8	20.8	8.3	Informal Discussion	8.3	16.7	50.0	16.7	8.3
25.0	4.2	33.3	25.0	12.5	Mentally Capable	20.8	0	29.2	20.8	29.2
8.3	16.7	37.5	8.3	29.2	Asking Questions in Class	16.7	8.3	50.0	8.3	16.7
62.5	12.5	12.5	8.3	4.2	Meeting Instructor	25.0	12.7	37.5	12.5	12.5
70.8	12.5	16.7	0	0	Phone/Email Instructor	50.0	20.8	20.8	4.2	4.2
12.5	12.5	37.5	20.8	16.7	Partner In Class	8.3	8.3	29.2	33.3	20.8
12.5	8.3	37.5	33.3	8.3	Group In Class	4.2	8.3	25.0	37.5	20.8

The strategies used least (never or less than somewhat) by those with medium anxiety were phoning or emailing the instructor (81.3%), speaking with a counselor about math experiences or difficulties (68.8%), meeting the instructor (68.8%), and tutoring (56.3%).

Table 4 Strategy Usage and Helpfulness - Medium Anxiety Participants (n=16)

Usage (%)						Helpfulness (%)				
1-Not at all	2	3-Somewhat	4	5-A lot	Coping Strategy	1-Not at all	2	3-Somewhat	4	5-A lot
43.8	12.5	18.8	6.3	18.8	Tutor	25.0	6.3	18.8	18.8	31.3
56.3	12.5	25.0	0	6.3	Counselor	25.0	25.0	31.3	12.5	6.3
12.5	6.3	43.8	31.3	6.3	Partner Outside Class	0	0	50.0	18.8	31.3
6.3	0	25.0	31.3	37.5	Informal Discussion	0	12.5	43.8	37.5	6.3
0	37.5	37.5	12.5	12.5	Mentally Capable	0	25.0	56.3	6.3	12.5
0	6.3	25.0	37.5	31.3	Asking Questions in Class	18.8	31.3	18.8	18.8	12.5
25.0	43.8	12.5	12.5	6.3	Meeting Instructor	18.8	37.5	31.2	0	12.5
68.8	12.5	12.5	6.3	0	Phone/Email Instructor	43.8	25.0	25.0	0	6.3
0	12.5	12.5	37.5	37.5	Partner In Class	0	0	31.2	43.8	25.0
0	6.3	25.0	43.8	25.0	Group In Class	0	0	25.0	37.5	37.5

High anxiety participants (n=7, Table 5) indicated their most used strategies as a partner outside of class (100%), discussing experiences or difficulties related to math with other students from class and asking questions of the instructor in class (both 85.8%), and working with a partner in class, working with a group in class, and reminding oneself of being mentally capable (each 71.4%).

Table 5 Strategy Usage and Helpfulness - High Anxiety Participants (n=7)

Usage (%)						Helpfulness (%)				
1-Not at all	2	3-Somewhat	4	5-A lot	Coping Strategy	1-Not at all	2	3-Somewhat	4	5-A lot
57.1	0	14.3	0	28.6	Tutor	14.3	42.9	14.3	0	28.6
42.9	28.6	28.6	0	0	Counselor	42.9	28.6	14.3	14.3	0
0	0	57.1	0	42.9	Partner Outside Class	0	0	57.1	14.3	28.6
0	14.3	42.9	0	42.9	Discussing Experiences	14.3	14.3	42.9	0	28.6
28.6	0	57.1	14.3	0	Mentally Capable	14.3	42.9	28.6	14.3	0
14.3	0	14.3	42.9	28.6	Asking Questions in Class	28.6	14.3	42.9	14.3	0
42.9	28.6	28.6	0	0	Meeting Instructor	42.9	28.6	14.3	0	14.3
57.1	28.6	14.3	0	0	Phone/Email Instructor	57.1	28.6	14.3	0	0
28.6	0	14.3	28.6	28.6	Partner In Class	14.3	0	28.6	14.3	42.9
14.3	14.3	28.6	14.3	28.6	Group In Class	0	14.3	28.6	28.6	28.6

Strategies used least by the high anxiety group (at levels below somewhat) included phoning or emailing the instructor (81.3%), speaking with a counselor and meeting with the instructor (both 68.8%), and tutoring (56.3%).

Table 6 provides a comparison among the three anxiety groups to highlight which group used each strategy the most by percent of participants. The medium anxiety group used 8 of 10 strategies more often than other learners.

Table 6 Coping Strategy Usage Comparison – Current Study

Coping Strategy	Utilized Most By Anxiety Level		
	Low	Medium	High
Use Tutoring Services		X	
Discuss Difficulties with Counselor		X	
Work with Partner Outside of Class			X
Discuss Experiences or Difficulties with Other Learners from Class		X	
Remind Yourself You Are Mentally Capable	X		X
Ask Questions in Class		X	
Meet Instructor on Material Not Understood		X	
Phone/Email Instructor on Material Not Understood		X	
Work with Partner in Class		X	
Work in a Group in Class		X	

Research Question #2 asked, "As customers of math education, what do learners of a midwestern technical college perceive as helpful coping strategies for their math learning environment that involve personal relationships?" The second section of the survey prompted these results through asking for the relative helpfulness of each strategy by answering, "how helpful has it been OR how helpful do you think it would be if you tried it?" Responses of somewhat or more were combined for the percentage results that follow.

Low math anxiety participants indicated the most helpful strategies were working with a group in class and a partner outside of class (both 87.5%), having a partner in class (83.3%), reminding oneself of being mentally capable (79.2%), tutoring and asking questions in class (both 75.0%).

Medium anxiety participants perceived it most helpful to have a partner in class, work with a group in class, and have a partner outside of class (each 100%), discuss experiences or difficulties related to math with other students from class (87.5%), and work with a tutor (68.9%). Half of these participants indicated asking questions in class as helpful.

High anxiety participants identified the most helpful strategies as a partner outside of class (100%), a partner in class, working with a group in class (both 85.7%), and discussing experiences or difficulties related to math with other students from class (71.4%).

Table 7 shows the relative rankings for helpfulness of the coping strategies. When summative percents for responses of somewhat helpful to a lot were the same, the distribution of responses from somewhat to a lot generally differentiated the rankings.

Table 7 Coping Strategy Helpfulness Rankings

Coping Strategy	Anxiety Level		
	Low	Medium	High
Use Tutoring Services	5	6	6
Discuss Difficulties with Counselor	9	8	8
Work with Partner Outside of Class	2	3	1
Discuss Experiences or Difficulties with Other Learners from Class	7	4	4
Remind Yourself You Are Mentally Capable	4	5	7
Ask Questions in Class	6	7	5
Meet Instructor on Material Not Understood	8	9	9
Phone/Email Instructor on Material Not Understood	10	10	10
Work with Partner in Class	3	2	2 tie
Work in a Group in Class	1	1	2 tie

Learning Environment/Relational Qualities

Research Question #3 asked, "Beyond coping strategies, what support or relational learning qualities do these learners associate with tension reduction in math?" The third section of the survey provided 17 affective possibilities of which they could select as many as were applicable to those they wanted in their math environment and then those they considered as helpful to reducing worry about math. Since they could want certain qualities for reasons not associated with tension reduction, both questions were asked to improve the clarity of results, presented in Table 8.

Table 8 lists the percents by anxiety level of those who considered the quality wanted plus helpful to reducing anxiety (Helpful) and the percents that combined responses of wanted alone with those marked wanted plus helpful (Total). The last column provides an overall percent of the interest of participants in having that quality present in their math learning environment (i.e. minimally they want it present).

One low anxiety participant did not respond to the qualities section at all and three medium anxiety participants indicated the qualities they wanted, while not indicating any as helpful to reducing worry. By not indicating any as helpful, it is unknown whether this represented their perceptions or whether they did not see or answer this last survey question. As a result, some helpful qualities identified by medium anxiety participants could be underrepresented by 0, 6.2, 12.5 or 18.8 percent, though their overall total percents, which combine wanted with helpful, would not be impacted. Data in Tables 8 and 9, for medium anxiety participants only, are potentially affected.

Table 8 Interest in Classroom Qualities (%)

Classroom Quality	Anxiety Level						Sample Total Interest
	Low (n=23)		Medium (n=16)		High (n=7)		
	Helpful	Total	Helpful	Total	Helpful	Total	
Work with partner	34.8	69.6	31.3	81.3	57.1	100	78.3
Work in groups	34.8	60.9	43.8	62.6	42.9	85.8	65.2
Work alone	26.1	69.6	6.3	37.6	0.0	14.3	50.0
Work with instructor	21.7	30.4	18.8	43.8	28.6	57.2	38.1
Instructor responds to class needs	39.1	86.9	37.5	81.3	57.1	100	87.0
A sense of hope is in the classroom	8.7	43.5	18.8	62.6	0.0	57.1	52.2
Organized competition	8.7	39.1	6.3	25.1	0.0	14.3	30.4
Internal competition	8.7	34.8	0.0	6.3	0.0	14.3	21.7
In class discussion	13.0	50.8	25.0	81.3	28.6	71.5	69.6
Electronic discussion	0.0	4.3	0.0	0.0	0.0	0.0	2.2
Someone in class understands me	8.7	39.1	12.5	37.5	0.0	42.9	39.1
Freedom to approach problems differently	13.0	52.1	0.0	56.3	0.0	57.1	54.3
A spirit of "we're in this together"	0.0	30.4	0.0	37.5	28.6	71.5	39.1
Friendships in class	39.1	60.8	12.5	50.0	14.3	85.7	60.9
Group members are held accountable	0.0	34.8	6.3	62.6	0.0	28.6	43.5
Classmates care about one another	4.3	34.7	0.0	56.3	28.6	71.5	47.8
Appropriate humor	39.1	73.9	25.0	56.3	0.0	57.1	65.2

Eight qualities were identified as the top five rankings for helpfulness (see Table 9). Participants identified an instructor who responds to class need as the number one ranked factor, regardless of anxiety level. Friendships in class and appropriate humor also tied for first among low anxiety learners while working with a partner tied for first among high anxiety learners. Other top qualities across two or three anxiety levels were working with a partner, working in groups, in class discussion, and appropriate humor.

Two learners (both low anxiety) thought internal competition was helpful to tension reduction, while 41 learners did not. Three learners (2 low, 1 medium) thought organized competition was helpful, while 40 did not. Electronic discussion was wanted by 1 learner but not marked as helpful, while 42 learners did not want it nor mark it as helpful. Anecdotally, all learners have campus email accounts, and their math instructor indicated that approximately 70% have internet access at home.

Table 9 Top Ranked Qualities to Reduce Tension

Quality	Helpfulness by Anxiety Level		
	Low	Medium	High
Instructor responds to class needs	1 tie	1	1 tie
Work with partner	4 tie	3	1 tie
Work in groups	4 tie	2	3
In class discussion	-	4 tie	4 tie
A spirit of "we're in this together"	-	-	4 tie
Classmates care about one another	-	-	4 tie
Friendships in class	1 tie	-	-
Appropriate humor	1 tie	4 tie	-

Note. Items marked with a hyphen can be viewed as percentages in Table 8 with all qualities.

Chapter V: Discussion, Conclusions, and Recommendations

Introduction

This chapter includes a recap of the rationale for the study, a discussion of Research Question #1, highlights of survey findings, conclusions drawn, and general recommendations for instructors and further research.

A comprehensive look at math anxiety could entail evaluating study skills, identifying gaps in knowledge, gleaning the relevance a learner attributes to math, identifying the classroom goal structure promoted or perceived, finding triggers of the past or present that block progress, assessing the influences of learning climate, etc. A range of approaches seems appropriate to maximize improvements.

Tobias' math clinics and personal self-help book emphasized emotional processing with content instruction (1991, 1993). Kitchens' work did, too (1995). The efforts of those who recognize and work on the affective realm of math anxiety do not do so instead of cognitive content work, but as an integral part. This study took the angle that an affective lens has a strong presence across math anxiety issues, and that learner perceptions are a powerful source for determining the affective elements that impact their own anxiety levels.

Discussion

This study collected anxiety data from 47 math learners from a midwestern technical college and used it for comparison to classroom climate factors. The goal was to determine learner perceptions of what is helpful to mitigating their math anxiety. While the data came from one instructor's classes, the survey was about the body of their math experiences and not about their current instructor or course.

Research Question #1 asked, "Are there any approaches to understanding or conceptualizing math anxiety that might freshen conversation on this topic?" To this end, the literature review offered brain function and resiliency as windows for looking at how each contribute to the affective resources available as learners cope with academic stress, of which math anxiety is certainly one.

The brain is a complex organ. It has as its primary function the survival of the organism. While human learning is a dynamic process involving the brain beyond the context of this study, the fundamental nature of the brain's use of emotion and priority assignment to ensure survival, decreasing or shutting down other cognitive processing if necessary, validates the importance of the affective learning environment. Helpful to all learners, math anxiety learners especially need positive affective experiences with math and to have supportive opportunities to rethink some of their negative experiences. The literature indicated several strategies such as discussing math difficulties with other learners to know one is not alone, using written reflections to sort what is being learned and to safely unload emotional math baggage, replacing one's negative self-talk with more positive and realistic messages, and working together on challenging problems. In conversation with the instructor of the learners in this study, the instructor shared that more vocal learners who expressed their frustration and anxiety about math seemed to do better academically than those suspected of keeping their frustrations inside.

Resiliency-building, as suggested by Search Institute and others, is the platform from which adolescents develop into healthy and productive adults. The extent to which developmental assets are present and working well for learners when they arrive at post-secondary institutions becomes their operational base for layering additional learning

experiences. In this study, 76.1% of technical college participants were traditional learners. It does not seem like a stretch to this researcher that they are continuing their asset development. Infusing resiliency-building into math education at the high school level was advocated by Malloy and Malloy (1998). Is post-secondary math education a place to extend resiliency-building to reduce adult math anxiety? What about learners (ages 17-60+) who do not have asset rich backgrounds? Learners facing serious deficits may need services outside the math classroom. The idea is whether a resiliency or asset development perspective has a place within it. This study presented work showing resiliency efforts overlap with relational and affective learning environment factors. For some educators or school programs, considering resiliency for assisting those with math anxiety does not need to compete with what is already being done to foster a good learning environment, rather it offers another language or slant from which to think about it.

Conclusions

In this study, learners rated multiple peer-connected coping strategies as the most used and the most helpful among the relationship strategies studied. When differentiated by anxiety level, the peer-oriented strategies remained in the top half. These included working in groups in class, working with a partner in or out of class, and discussing experiences and problems about math with their classmates. Low anxiety learners were more apt to think asking questions of the instructor in class yielded favorable results than their classmates. In the Peskoff study of community college math learners (2001), the coping strategies were not all relational. Its top three strategies were completing one's homework on time, letting the instructor know when material was not understood, and

allowing extra time to study for tests. Communication with the instructor was its highest relational coping strategy.

Medium anxiety learners appeared to use coping strategies more than either the low or high anxiety learners in this study. In the community college study (Peskoff, 2001), learners were grouped only into low and high anxiety categories. There the low anxiety group was found to use a wider range and more strategies than the high anxiety group. The idea of higher academic self-efficacy among the low anxiety group was thought to explain the difference. In the present study, it may be that the medium anxiety group used more strategies than the low anxiety group out of having a greater need for them, and they used more strategies than the high anxiety group out of a greater sense of self-efficacy. While the Peskoff study rated letting the instructor know if material wasn't being understood as one of the best coping strategies, the current study showed asking questions in class and meeting the instructor for help as middle to low ranked items, and more so for high anxiety learners. The sample size, however, was particularly small for the high anxiety group. The lowest ranking strategies in Peskoff's group were tutoring and counselor discussion, and these strategies were also low ranked items for usage and helpfulness here.

From the perspective of the researcher, an affective approach to countering math anxiety may have three points of attack: better understanding of what the brain is or is not doing during anxiety so that the role of emotion during learning is not undervalued with adults; drawing learners toward realizing that the presence of anxiety is not a sign of lacking the intellect necessary for math competence; and promoting a learning environment that supports more learners, keeping particularly attuned to learners with

anxiety. Strategies and classroom qualities promoted would seek ways to positively impact all learners, yet any differences between those factors with respect to anxiety levels would be one legitimate way to prioritize efforts.

Recommendations

Study Replication

The relatively low quantity of participants in this study means there is limited generalizability of findings beyond the institution's face-to-face math classroom population. No ethnic/race data were collected on the survey, though the sample was observed by the researcher as considerably European-American. A larger sample is recommended so statistically valid correlations between anxiety levels and respective perceptions could be calculated for the population of interest.

The use of three variables to determine a learner's math background was initiated as a theoretical improvement over the more common solo variable of years of high school math. It turned out that there was a statistically significant relationship (rho=0.325; p=0.029) between anxiety by gender and years since a prior math course for this sample. Replication with more participants at each anxiety level would better confirm whether multi-variables for math background are valuable. The use of the block scheduling question toward common interpretation of the number of high school years of math a learner had is not clear from the data obtained.

Instructors

As practitioners committed to having math learners master competencies for success in their respective careers, the literature points to the importance of positive affective qualities within the learning environment. Regarding math anxiety, this includes

making opportunities for learners to express their apprehensions about math and to experience positive feedback, given emotion's central role in learning and how negative emotion can shut down cognitive processing. This can look differently for different practitioners and be guided by the learners. Options could include:

- Invite the learners' input prior to the end of class evaluation. Individually designed surveys, journaling, group discussion, or a learning environment inventory can offer insights. Educators often have a more positive view of their classroom environments than do their learners (source unknown). Combine past experiences with the perspectives of current learners.
- Ask a colleague to observe several classroom sessions for feedback specifically on affective qualities of interest, displayed by learners and the educator.
- Initiate data collection on why learners underutilize certain strategies like tutoring or meeting the instructor outside of class. This can be but does not have to be formal. Are certain inhibitory logistics or perceptions able to be modified?

Further Research

An affective lens across components of math anxiety could be looked at from the instructor's viewpoint. What is the prevalence and perception by faculty using competency-based math instruction on the inclusion of affective learning climate factors? Do some forms of promoting a healthy learning climate compete with other forms? Which factors yield strongest results given the amount of time a learner spends in technical college math courses? To what degree does faculty report getting emotional and inservice support for including social and support factors for learners?

Resiliency within learners has focused on those 12 to 18 years of age. To what extent are the assets, or the relationships that foster the assets, relevant to math anxiety reduction in adults? How different would a list of assets for post-secondary learners look or does it change significantly over the span of an adult learner's lifetime? Social learning theory and cooperative learning would be two bodies of work, some dealing with adult learners, to show overlap with the youth assets. A broader literature search and more research could help address these questions. As post-secondary institutions serve growing numbers of non-traditional learners, determining the longevity and importance of developmental assets for non-traditional learners will increase.

References

Archambeault, B. (1993, September-October). Holistic mathematics instruction. Interactive problem solving and real life situations help learners understand math concepts. *Adult Learning, 5*(1), 21-23.

Arem, C. S. (2003). *Conquering math anxiety. A self-help workbook* (Second Edition). Pacific Grove, CA: Brooks/Cole Publishing Co.

Baloglu, M. (1999). *A comparison of mathematics anxiety and statistics anxiety in relation to general anxiety.* (ERIC Document Reproduction Service No. ED 436 703)

Bankhead, M. (2002). *Reducing math anxiety, improving standards, and maximizing student participation and student interaction using special techniques and peer responsibility. A practical solution for the classroom.* (ERIC Document Reproduction Service No. ED 474 799)

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*(5), 441-448.

Dirkx, J. M. (2001). The power of feelings: Emotion, imagination, and the construction of meaning in adult learning. In S. B. Merriam (Ed.), *The new update on adult learning theory* (pp. 63-81). San Francisco, CA: Jossey-Bass.

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman mathematics attitudes test. *Tests in Microfiche*, Set D, p. 15.

Godbey, C. (1997). *Mathematics anxiety and the underprepared student.* (ERIC Document Reproduction Service No. ED 426 734)

Holley, L. C., & Steiner, S. (2005, Winter). Safe space: Student perspectives on classroom environment. *Journal of Social Work Education, 41*(1), 49-64.

Jensen, E. (1998). *Teaching with the brain in mind.* Alexandria, VA: Association for Supervision and Curriculum Development.

Kitchens, A. N. (1995). *Defeating math anxiety.* Chicago, IL: Richard D. Irwin, Inc.

Malloy, C. E., & Malloy, W. W. (1998, May/June). Resiliency and Algebra I: A promising non-traditional approach to teaching low-achieving students. *Clearing House, 71*(5), 314-317. Retrieved November 2, 2005, from: EbscoHost database.

Merriam-Webster's collegiate dictionary. (10th ed.; 2000). Springfield, MA: Merriam-Webster, Inc.

The New Oxford American dictionary. (2001). Oxford, NY: Oxford University Press.

Patrick, H., Turner, J. C., Meyer, D. K., & Midgley, C. (2003). How teachers establish psychological environments during the first days of school: Associations with avoidance in mathematics. *Teachers College Record, 105*(8), 1521-1558.

Perry, A. B. (2004, June). Decreasing math anxiety in college students [Electronic version]. *College Student Journal, 38*(2), 321-324. Retrieved November 11, 2005, from: Wilson Web.

Peskoff, F. (2001). *Mathematics anxiety and the adult student: An analysis of successful coping strategies.* (ERIC Document Reproduction Service No. ED 474 042)

Ryan, A. M., Gheen, M. H., & Midgley, C. (1998). Why do some students avoid asking for help? An examination of the interplay among students' academic efficacy, teachers' social-emotional role, and the classroom goal structure. *Journal of Educational Psychology, 90*(3), 528-535.

Ryan, A. M., Patrick, H., & Shim, S. (2005). Differential profiles of students identified by their teacher as having avoidant, appropriate, or dependent help-seeking tendencies in the classroom. *Journal of Educational Psychology, 97*(2), 275-285.

Safford-Ramus, K. (2001). *A review and summary of research on adult mathematics education in North America (1980-2000).* (ERIC Document Reproduction Service No. ED 478 899)

Salinas, T. M. (2004, December). Effects of reflective notebooks on perceptions of learning and mathematics anxiety [Electronic version]. *PRIMUS, 14*(4), 315-327.

Scales, P. C., & Roehlkepartain, E. C. (2003). Boosting student achievement: New research on the power of developmental assets. *Search Institute Insights & Evidence, 1*(1), 1-10. Retrieved December 1, 2005, from: http://www.search-institute.org/research/insights

Sesma, A., Jr., & Roehlkepartain, E. C. (2003). Unique strengths, shared strengths: Developmental assets among youth of color. *Search Institute Insights & Evidence, 1*(2), 1-13. Retrieved December 6, 2005, from: http://www.search-institute.org/research/insights

Sousa, D. A. (2006). *How the brain learns* (Third Edition). Thousand Oaks, CA: Corwin Press.

Spandel, V. (2005). *Creating writers through 6-traint writing assessment and instruction* (Fourth Edition). Boston, MA: Pearson Education, Inc.

Sprenger, M. (1999). *Learning & memory. The brain in action.* Alexandria, VA: Association for Supervision and Curriculum Development.

Taylor, B. A., & Fraser, B. J. (2003). *The influence of classroom environment on high school students' mathematics anxiety.* (ERIC Document Reproduction Service No. ED 476 644)

Tileston, D. W. (2000). *10 Best teaching practices. How research, learning styles, and standards define teaching competencies.* Thousand Oaks, CA: Corwin Press, Inc.

Tobias, S. (1993). *Overcoming math anxiety. Revised and expanded.* New York, NY: W. W. Norton Company, Inc.

Tobias, S. (1991, Summer). Math mental health: Going beyond math anxiety. *College Teaching, 39*(3), 91-93.

Ulrich, M. B. (1989). *A study of adult participation in mathematics courses as a function of mathematics anxiety and other variables.* Retrieved November 15, 2005, from: http://wwwlib.umi.com/cr/ilstu/fullcit?p8907679

Appendix A: Developmental Assets Related to Academia

Category	Asset and Description
Support	Adult relationships – person receives support from three or more non-parent adults Caring school climate – school provides a caring, encouraging environment
Empowerment	Safety – person feels safe at home, school, and in the neighborhood
Boundaries & Expectations	School boundaries – school provides clear rules and consequences Adult role models – adults model positive, responsible behavior Positive peer influence – person's best friends model responsible behavior High expectations – both parent(s) and teachers encourage the person to do well
Constructive Use of Time	Programs – person spends three or more hours per week in sports, clubs, or organizations at school and/or in the community
Commitment to Learning	Achievement motivation – person is motivated to do well in school School engagement – person is actively engaged in learning Homework – person reports doing at least one hour of homework every school day Bonding to school – person cares about her/his school
Positive Values	Caring – person places high value on helping other people Integrity – person acts on convictions and stands up for own beliefs Honesty – person "tells the truth even when it is not easy" Responsibility – person accepts and takes personal responsibility
Social Competencies	Planning and decision making – person knows how to plan ahead and make choices Interpersonal competence – person has empathy, sensitivity, and friendship skills Cultural competence – person has knowledge of and comfort with people of different cultural/racial/ethnic backgrounds Resistance skills – person can resist negative peer pressure and dangerous situations Peaceful conflict resolution – person seeks to resolve conflict nonviolently
Positive Identity	Personal power – person feels control over "things that happen to me" Self-esteem – person reports having a high self-esteem Sense of purpose – person reports that "my life has a purpose" Positive view of personal future – person is optimistic about her/his personal future

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.

Consent to Participate in UW-Stout Approved Research

Title: Determining the Comfort Levels and Perceptions of Math Learners on Selected Coping Strategies in Mathematics

Investigator:
Cheryl M. Sutter
736 Bolles St.
Eau Claire, WI 54703

Research Sponsor:
Dr. Amy Gillett, UW-Stout
gilletta@uwstout.edu
(715) 232-2680

Description: The purpose of the study is to collect data from adult math learners to compare their math comfort levels with the prevalence/effectiveness of some social factors related to math. Participants will be currently enrolled in a math course at a Midwestern technical college. The data is collected through a three-section survey.

Risks and Benefits: There is no perceived risk for the participant or the technical college. As potential benefit, a participant may become aware of another avenue for math support or encouragement from completion of the survey. The data a participant supplies will help inform the investigator and broader audience who have an interest in math anxiety among learners.

Time Commitment: Approximately 10 minutes

Confidentiality: Your name is not collected on this survey document and no participant names will be seen by the investigator at any point in this study. All information collected will remain anonymous.

Right to Withdraw: Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. If you choose to participate and later wish to withdraw from the study, there is no way to identify your anonymous document after it has been turned in to the investigator.

IRB Approval: This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and university policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

Investigator:
Cheryl M. Sutter
(715) 836-7903
sutterc@uwstout.edu

Advisor:
Dr. Amy Gillett
(715) 232-2680
gilletta@uwstout.edu

IRB Administrator
Sue Foxwell, Director, Research Services
152 Vocational Rehabilitation Bldg.
UW-Stout
Menomonie, WI 54751
(715) 232-2477
foxwells@uwstout.edu

Statement of Consent: By completing the following survey found in this booklet, you agree to participate in the study entitled, *The Anxiety Levels and Perceptions of Mathematics Learners from a Midwestern Technical College on Selected Classroom Climate Factors in Mitigating the Effects of Math Anxiety.*

Demographic Information
Name of Current Math Course:_____
Your Program Name: _____
Gender (please circle): Male Female Age: _____

How many years of high school math did you pass?_____
Was any of your high school math taken through block scheduling? (please circle) Yes No
How many math courses have you passed since earning your high school or GED diploma?_____
How many years has it been since your last math class? _____
Do you wish to clarify any of your answers? _____

Survey on Comfort Level with Math

The following ten items are statements that may represent your feelings about math.
Please complete all items and clearly circle the answer that best represents your feelings.

SA = Strongly Agree A = Agree U = Undecided D = Disagree SD = Strongly Disagree

1. SA A U D SD I wouldn't mind taking more math courses as long as it didn't require more time and money.
2. SA A U D SD I get a sinking feeling when I think of trying hard math problems.
3. SA A U D SD My emotions about math generally hurt my performance on a math test.
4. SA A U D SD I usually don't worry about my ability to solve math problems.
5. SA A U D SD I seldom get concerned when something math-related comes up in real life.
6. SA A U D SD My mind goes blank and I am unable to think clearly when doing math.
7. SA A U D SD I have usually been at ease during math tests.
8. SA A U D SD I have usually been at ease during math courses.
9. SA A U D SD Math makes me feel uncomfortable and nervous.
10. SA A U D SD Math can make me feel physically ill.

Do you wish to clarify any of your answers or share anything else concerning your comfort level with math? _____

_____

_____

Please continue on next page. →

Survey on Selected Relational Behaviors used as Coping Strategies for Math

The following is a partial list of strategies that students may use in order to learn mathematics effectively and do well in their math courses. Please respond to both questions listed below each of the following behaviors. Clearly circle the most appropriate number for you from 1 to 5 where:

1 = not at all 3 = somewhat 5 = a lot

Please respond to all questions in relation to your math experiences.

1. Using the school's tutoring center or a private tutor
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

2. Discussing with the school counselor my math course experiences or difficulties
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

3. Meeting a study partner outside of class to work on homework or prepare for quizzes/tests
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

4. Discussing experiences or difficulties related to your math course with other students from class
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

5. Reminding yourself that you are mentally capable even when you start to feel incompetent
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

6. Asking your instructor math questions in class
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

Please continue on next page. →

1 = not at all 3 = somewhat 5 = a lot

7. Meeting your instructor in person for help on material you don't understand
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

8. Conversing by phone or email with your instructor for help on material you don't understand
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

9. Working with a partner during class to review, clarify, solve problems, or encourage one another
   a. How often have you tried this? 1 2 3 4 5
   b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

10. Working with a group of students during class on activities that review, clarify, solve problems, or encourage one another
    a. How often have you tried this? 1 2 3 4 5
    b. How helpful has it been OR how helpful do you think it would be if you tried it? 1 2 3 4 5

Survey on Selected Relational Qualities in Math Education

Of the following possibilities, which ones do you want in your math learning environment?

1. Check all that apply.

_____	working with a partner	_____	in-class discussion
_____	working in groups	_____	electronic discussion
_____	working alone	_____	someone in class who understands me
_____	working with the instructor	_____	being free to approach problems differently
_____	an instructor who responds to class needs	_____	a spirit of "we're in this together"
_____	a sense of hope in the classroom	_____	friendships in class
_____	organized competition (e.g. quiz bowl, review games)	_____	all group members being held accountable for group work
_____	internal competition (ways to compare my performance to that of my classmates)	_____	classmates caring about one another
		_____	appropriate humor

2. Of the items you checked, clearly circle those that help you reduce any tension or worry about math.

Thank you for your time and participation. Again, all responses will remain anonymous.